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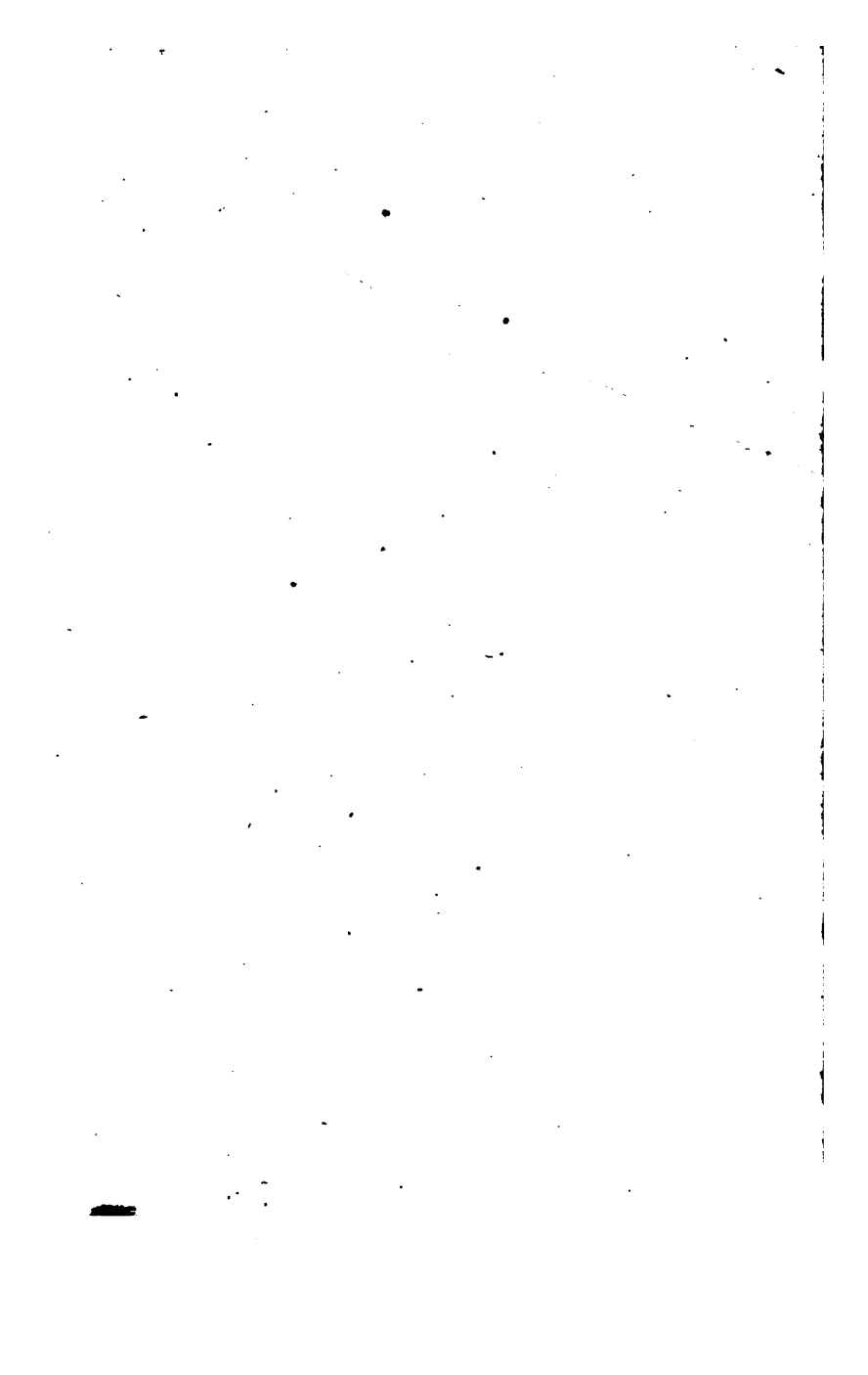
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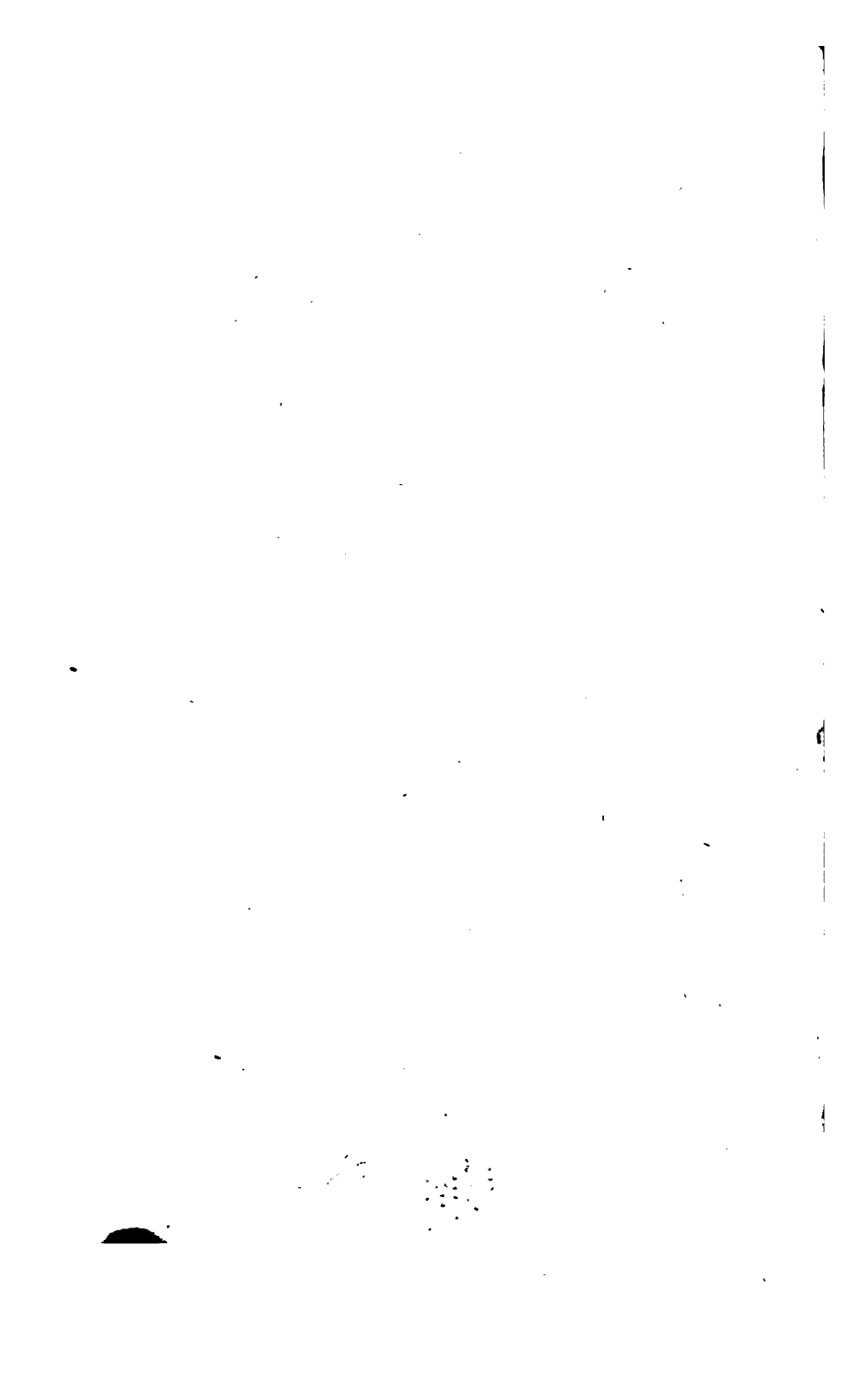
A  
CONCISE DESCRIPTION  
OF THE,  
GEOLOGICAL FORMATIONS  
AND  
MINERAL LOCALITIES  
OF  
THE WESTERN STATES;  
DESIGNED AS A KEY  
TO THE  
GEOLOGICAL MAP  
OF THE SAME.

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BY BYREM LAWRENCE.

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BOSTON:  
PRINTED BY SAMUEL N. DICKINSON.  
1843.



GIFT OF  
MISS MARIE ROMINGER  
AND  
MRS. MARK COVILL

FEB 13 1937

## PREFACE.

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It is *not pretended* that this little book, and the accompanying map, will describe very minutely the geology of the West, for both the subject and the country are too new to admit of a finished production of this kind, so soon; but *it is pretended*, that it gives such a view of its principal features, and with such accuracy, as to enable any person who may travel there, after reading it, to know the meaning of the frequent and sudden changes which he will meet with in the rock formations, and in the character of the soil, its productions, and the condition of the inhabitants of the region through which he passes. Most of the information which it contains has been obtained by actual observation, during the last three years; to which, during this time, the writer has been exclusively devoted.

Its principal excellence as a geological production, consists in the general view it gives of the whole country; which will enable any one to locate all the items of knowledge, which he may hereafter gain by observation, or by reading; and which will enable him to perceive them to be parts of the great system of nature; instead of supposing them, as most do, to be isolated facts, unconnected with any system, or the designs of an intelligent Being.

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There is another idea which it suggests, in relation to the extension of the elements of natural science in our schools ; and that is, by representing the geology as well as the geography of the country, upon the same map, and thus communicating a knowledge of both at the same view. Would it not be a great improvement in our school maps, if the colorings, with which they are ornamented, were made to represent the outlines of the geology of the country which they represent, instead of serving little other than the purposes of ornament ? They would be none the less ornamental ; and, to a mind desirous of knowledge, it would be much more interesting to know, that these colors are sketches of the great frame-work of the globe, instead of representing merely the artificial divisions of its surface.

Such a plan would induce the spirit of inquiry and observation beyond any other, that has yet been tried, to see whether these things are so. It would make known some of the fundamental facts in geology in such a way, as to awaken an interest in almost every mind, which is seldom felt on this subject. To say the least, such a thought is worthy of consideration ; and with a view to test its efficacy, this little key, with the accompanying map, is submitted, by way of experiment, to the decision of a discerning public.


## GEOLOGICAL FORMATIONS, ETC.

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THIS is the first attempt which, to my knowledge, has ever been made, in this country, to publish a Geological Map for popular use. But since the interior of the earth, or rather the structure of its mineral masses, is capable of being represented on a map, as well as the form and structure of its exterior; and since the knowledge of the former is every way as important as those of the latter; I see no reason why such a thing should be delayed any longer. Most persons are in the habit of regarding the earth as a confused mass of rocks and stones, seeming to be thrown together without any order or evidence of design. And true it is, that such is its appearance upon and near the surface; and since few ever look much below the surface, it is not surprising the impression should be general, that the whole earth is a mass of confusion, or a mere pile of rocks.

But this state of disorder is only superficial, and consists almost entirely of the fragments and detritus of rocks, which have, by violence, been torn from their parent masses, moved about to a greater or less distance from their native place, and left in the confused state in which we now see them. These are nature's ruins—the ruins of her great masonry, which once lay in structures as regular, and as systematic, as those formed by the hand of man; beneath which the same regularity now prevails, where it has not been disturbed by some upheaving force from beneath.

We read of ancient cities that were once the glory of the world, on account of their splendid magnificence, and their display of human skill and power. But all that can be seen of them now, is a heap of rubbish; with here and there a fragment, containing some relic of their former grandeur. And if the antiquary delights to contemplate these ruins, that through them he may get a glimpse in imagination of what they once were, and a clue to their history,



and the means by which they have been thus laid low ; so does the geologist delight to trace the changes through which our globe has passed, and contemplate its history as he finds it revealed in the study of these its ruins ; and written upon the face of the unbroken rocks, in the regularity of their structure, and in the abundance of organic remains which they contain.

This little book is designed to be a Key to the accompanying Geological Map of the Western States. It cannot be fully understood without the map, and the map cannot be at all understood without the book. Therefore, whoever reads the one must have the other open before him, and find all the places referred to as they occur.

Reader, I am not going to write round about the subject a great while, before I write any thing that has any meaning in it ; but come at once to the merits of the cause ; that is, to write a description of the geological formation of the Western States, and likewise of their soil and productiveness ; the cause of their unexampled fertility ; their future prospects in regard to population and wealth ; their healthy and unhealthy parts ; and such other information as may be supposed to be of importance for those to know, who feel an interest in that portion of our common country ; to those who may wish to remove thither ; and to those who are now living there. And as I intend to make a short work of it, and to have every sentence mean something, therefore you must have the eyes and ears of your minds wide open, and look well to the map, or you will not understand more than half that I intend to communicate.

What I write is not the result of imagination, nor a repetition of what others have written ; for very little of it was ever before attempted to be written. It is the result of my own observations, what I have myself seen. I have not travelled much by stages, or steamboats, or railroads ; for by this means, a person can never get more than a birdseye glance of any country. But I have travelled on foot many thousands of miles, and have examined the rocks, as it were, step by step, to learn the exact limits of the different formations ; to find the extent and localities of the minerals which they contain ; and the visible characteristics of the soil in different parts of the country. My travels have been confined to the limits embraced on the map ; thinking it better to represent this much faithfully, than to embrace a much larger territory, about which I had

no certain knowledge. And even here, I do not pretend to relate, or even to know every thing that might be important and interesting to know; but my object is to give such an account of the structure and formation of the country, that any person, by faithfully studying it, might know where to look for any particular kind of rock, or soil, or mineral, or scenery, which the country contains, and he may wish to find.

The geological structure of the Western States differs greatly from that of those bordering on the Atlantic, both in the kind of rocks which they contain, and in the manner in which they lie beneath the soil. And this it is which gives rise to so great a diversity of soil and of scenery, and determines, in a great measure, the pursuits of the inhabitants.

The Eastern States abound in hills and mountains, which have been elevated, or heaved up by some powerful force, from beneath, which has broken the rocks in pieces, thrown them out of their original beds, and tilted them up, so that, instead of lying in their original, horizontal position, they are now found leaning against the sides of the hills and mountains as they were left by the upheaving force, and sometimes sitting perpendicularly upon their edges, as everlasting memorials of the violence and power of the force that elevated them. Much of the country is likewise strown over with large and small fragments of the rocks which were broken off by the violence of their upheaval; and which now tell, in forcible language, the extent of the ruin to which they have been subjected.

But the West has no mountains, nor even hills, except such as have been produced by the action of running water, or what are termed by geologists hills of degradation. The rocks here have never been broken by violence, nor tilted up as in the East, but lie apparently horizontal in the sides of the hills, and stretch away to a great distance, nearly parallel to the almost level surface. Rocks are seldom seen, except in the sides of hills along the banks of streams, which have worn their own beds down through their strata, and thus exposed their edges. Here they are quarried out for building purposes; and they often lie in rows or ranges as straight, and with as much regularity, as the most finished masonry, and appear almost to be the work of art, were it not for the magnitude of their extension.

A person might travel whole days, in some directions, without seeing any rocks, and might hence conclude there were none in

the country ; when, in fact, the solid crust of the globe, which consists of nothing but rocks, is, on an average, within ten feet of the surface. Although they are so near him, the traveller is ready to conclude there are none, because he does not see them. This is in consequence of their being no upheavals, and the remarkable evenness in the depth of the soil by which they are covered. The first settlers of Cincinnati, because they saw no rocks, supposed that none could be obtained in the country for building purposes. Whereas, the whole mass of the hills, which surrounded the city, consisted of nothing else, except a covering of a few feet of soil, which hid them from view. These are laid with all the symmetry of art, and quarrying them seems much like taking down a regularly built wall. So it is in every part of the country ; though no rocks may be seen for many miles, yet they every where exist at no great depth below the surface. Still in many places it is impracticable, to obtain them for building purposes, on account of the levelness of the country, and the too great depth of earth above them. The principal places where stone are quarried, are upon the sides of hills, near the streams, where the water has cut through the layers, carried off the soil, and left them either bare, or with a very thin covering of earth.

One of the most striking peculiarities in the geological formation of the West, is the great regularity of the rock formations, and the often sudden transition from one to another, in travelling over the country. For instance, a person may travel for many miles, even when rocks are plentifully to be seen, without being able to find but a single kind ; not even a piece large enough for a cabinet specimen, unless it has been transported thither as a boulder, or by some other means.

At length he meets with some other kind of rock, and now this is the only kind that can be found ; and he might search in vain for the smallest piece of the former rock. These changes are often too of rocks of the most dissimilar kind ; as from limestone to slate, and from slate to sandstone. So sudden is the transition frequently, that in a single step we pass from one to the other, and find the change complete. In some portions of the country, limestone is only to be found ; while in others, one might search in vain for the smallest piece of limestone. In another region slate can only be found ; in another sandstone ; in another conglomerate ; in another shale.

Certain regions abound in coal, and in these regions coal may be



found in every place; though not every where with equal facility. Out of these regions it would be utterly in vain to look for it, because it does not exist. And these regions are as distinctly marked and accurately defined by nature, as the boundary between the ocean and the land. A man may stand on the borders of one of these fields, and say to the inquirer, here, on my right hand, you may dig, with the certainty of finding coal that shall repay the labor of mining, while on my left, you would find none, though millions were spent in the search.

How important, then, is it, that a knowledge of the geological structure of the country should be understood by the people generally, to prevent unreasonable expectations of mineral treasure, and the waste of labor and capital in a fruitless search for it, where it does not exist; as well as to point out with certainty where it does exist, and the best methods of obtaining it. Already have hundreds of thousands, if not millions of capital and labor, been wasted in searching for coal, for silver, for lead, copper, and iron; and in unnecessarily expensive excavations for wells, for salt water; and upon railroads and canals, which, with a very little knowledge of the real structure of the country, might have been saved, and the withering influence of disappointed hopes have been prevented.

There is no country in the world where there is such an inexhaustible supply of almost every article in the mineral kingdom, which is of indispensable utility to man, as in the West. Yet this does not warrant us in supposing we can find every thing we want in every place; not always even when there seem to be promising indications of its existence. There is probably more coal in these Western States, than in all the rest of the world; the same may also be said of lead. And there is no other part of the world, where they are mined with so little labor. Iron, copper, and zinc are likewise in sufficient abundance for all the wants of the country. Silver probably does not exist in any of the known parts of the country, except the very small quantity which usually exists in lead ore. Gold is said to be found in the Ozark mountains, in the southern part of Missouri, but to what extent is not yet known.

To the mineralogist, except in the articles just mentioned, the West is rather barren, compared with the Eastern States. Yet there are some articles, even here, that will ornament the cabinet, and feast the mind, of the student of nature, with the beauty of her

works. Among these, calcareous spar is the most common. In the rhombic, or primitive form, it is exceedingly abundant. It is found most plentifully in the limestone of formation 2d. The most beautiful variety is found in Washington county, Missouri, in the neighborhood of Postosi. (See map.) In the form of dog-tooth spar, it is found in some places, of rare beauty and excellence, generally accompanied with pearl spar, of a most beautiful pink color; but the latter usually fades on long exposure to the light. The most noted places for these specimens are Madison, in Indiana, and near Burlington, in Iowa. Fluor spar is found in various places, in small quantities; the principal localities known are a few miles back of Shawneetown in Illinois. Here it is in great quantities. Stalactites and stalagmites of every size and variety, are found in the caves of the limestone formations 2 and 5, especially the latter. Those of the Mammoth Cave in Kentucky, and a cave on Blue river, about four miles from the town of Leavenworth, Ia., are the most remarkable.

Some kinds of siliceous minerals are also found in considerable abundance. Drusy crystals of quartz in geodes, or hollow, isolated concretions of the same mineral are found in immense quantities in Boyle county, Kentucky, and to some extent in various other places, in the same State, and in Indiana. The same article of rare beauty is also found imbedded in the limestone near Burlington, in Iowa. These concretions are almost as round as cannon balls, and from the size of grape-shot to a foot in diameter. Many of them are hollow, like bomb-shells, the inner surface being thickly studded with quartz crystals, or the people's diamonds. The shell of these concretions is sometimes chalcidony, and more rarely agate. Cornelian and agate are found in various places; the former in greatest abundance in Missouri, near Herculanum and the south shore of lake Superior, the latter in Arkansas.

But to the geologist, the West presents a field of unrivalled interest. In this department, the student of nature may revel in inexhaustible sources of intellectual wealth. Wherever he turns his eyes, he sees countless myriads of the petrified forms of the inhabitants of a former world. Every where the rocks contain them; and in many places, especially in the limestone region, they constitute a large portion of the rock; sometimes almost the whole. These fossil remains consist of a great variety of marine shells, cyathophylla, orthoceratites, archimedes, corallines, encrinites, and many

other kinds of radiated animals, in the older formations ; and in the newer formations, or coal-series, there is the greatest abundance of fossil plants, particularly in the shales, pressed together into the thinness of paper, by the weight of the superincumbent rocks, yet exhibiting upon their surfaces, when split open, the most astonishing variety and abundance of the impressions of plants, as perfect, in all their minutest, and slenderest parts, as when they were alive, or as distinctly visible as they could be impressed on paper.

These remains are found not only at and near the surface all over the country, but filling the rocks to a great depth below it, from nothing to that of two or three thousand feet deep. So plainly visible are they, and so perfect in all their minutest parts, that when viewed upon the fresh surface of a newly quarried rock, they seem almost as if they were the shades or ghosts of those departed creatures, which had risen up to tell us, in these latter days, that they have once been.

These things demonstrate, that the whole country under consideration once formed a part of the bed of the ocean. For as these remains are nearly all of marine origin, there is no other way of accounting for their existence here, in such amazing numbers. Had they been transported there from the present oceans, all their minutest parts must have been worn away. Nay, some of the corallines and other zoophytes are now found in the very places where they grew ; their roots, or rather the enlargement of the place of their attachment to the rocks being often seen, and now standing in the place where it grew. All these fossiliferous rocks, then, must have been formed under the ocean, by sediment that subsided from the water, among which these animal remains were mingled, as the successive generations of them died.

But notwithstanding all these manifestations of the hosts of living creatures that occupied these regions before the rocks grew ; yet a careless observer, or rather one who does not observe at all, might travel over that country, or even live in it for years, and know nothing of these records of a former world ; never observe them. Or if he does occasionally notice them, he knows not what to think of them, gets no ideas from them ; supposes they were always there, or that they were made so when the world was made, and here ends his inquiries on the subject.

But these are the records which the God of nature has stamped upon these rocks ; that teach us the history of their formation, and of the globe. They bring to our knowledge much of the scenery

and circumstances of the earth, when it was inhabited only by the lowest orders of animate beings. It shows us that the earth has been the abode of innumerable multitudes of these inferior animals and plants, and that its surface was enlivened by their presence and their sportings, thousands of ages before man commenced his career: that while the earth was in a forming state, and preparing for the comfortable residence of the higher orders of animals; it was not left a lifeless waste; but was made to minister to life, and consequently to enjoyment, while as yet it was not in a condition suited to the residence of creatures of a more complicated mould.

### DESCRIPTION OF THE MAP.

**FORMATION 1.** I will now describe the various formations, or different kinds of rocks, that occur in the country represented by the map, beginning with the lowest, or oldest. This is represented by the blue color, with Cincinnati nearly in the centre, extending to Dayton on the north, and four miles beyond Danville, in Kentucky, on the south, to West Union on the east, and to Madison, Indiana, on the west; lying in an oval form. It is about one hundred and seventy miles long, and about one hundred and twenty-five broad. Over this whole extent, no other rock can be found but limestone. It is the first rock met with beneath the soil, and extends downward in every part, to the depth of a thousand feet, or more. It lies in apparently horizontal layers or strata, of moderate thickness, generally from four to six inches. Between these are layers of what appears to be blue clay, but in reality, are clay marl, consisting of a mixture of lime and clay. Before exposure to the atmosphere, this substance, although quite soft, is somewhat difficult to excavate, on account of its toughness; but on exposure for a while to air, rains, and frost, it falls to pieces, and is not to be distinguished from the common soil of the country. It is, in fact, limestone, having so large a proportion of clay in it, as to destroy its durability when exposed to the action of the elements. And the limestone proper, consists of the same materials, but in different proportions; having a larger share of lime, which causes its greater hardness and durability. These two varieties are interstratified with each other, or alternate, so that two layers of the same kind are never found in contact in their natural state. The limestone layers form one of the best building materials for common walls in the whole country; owing to its

convenient thickness, and the great ease with which it is quarried. But it is not suitable, except in a very few places, for the heavy masonry of public works, on account of the thinness of its layers. It is semi-crystalline in its structure, as is shown by the great number of glittering points which it exhibits when newly broken. Much of it is of sufficient compactness to admit of a good polish, and is beginning to be used for ornamental purposes, in Cincinnati and elsewhere. It is almost uniformly of a blue color, like that represented on the map.

But there is one portion of it, of a limited extent, which is an exception, both in color and structure. The layers of limestone here are much thicker, and are without any strata of clay marl between them; the rock is mostly of a light drab color, sometimes variously spotted or clouded with darker shades; compact, breaks with a highly conchoidal fracture, brittle, and entirely uncrystalline. This variety is found at Frankfort, Kentucky, commencing a few miles to the northwest of that place, and extending on both sides of the Kentucky river for twenty or thirty miles to the southeast. It is sawn into slabs at Frankfort, and other places, and converted to purposes of ornament under the name of Kentucky marble. The State House at Frankfort is built of it.

**Fossils.** This formation abounds more than any other in the country in fossil remains; but in general, they are remarkable for their small size, though the rock is often completely filled with them. These consist of a variety of marine shells, among which the most common are *delthyris*, *atrypa*, *orthis*, *strophomena*, and *productus*; *trilobites*, *orthoceratites*, *corallines*, *cyathophylla*, *encrinites*, and a number of other radiata.

**Metals.** This formation is destitute of metals of any kind, in sufficient quantity for working, though there are several small lead veins in the vicinity of Owenton, Frankfort, and Lexington, Kentucky, some of which might be profitably worked, if it were not for the great abundance of richer mines, in other parts of the country. These mines, though unprofitable to the miner, afford some rich specimens of galena, blende, calcareous spar, heavy spar, and iron pyrites; all of which may frequently be found faithfully represented in a single specimen.

**Dip.** It would be inferred, by any one unacquainted with the real structure of the country, on observing that the rock of this formation wholly disappears beyond the boundaries laid down on the map, that it had come to a sudden termination, and that its place

beneath the soil was supplied by the rocks of formation second. But this is not the fact, for it does in reality continue on in full force ; but by reason of a gentle inclination, or dip, in every direction from the centre, it passes beneath the succeeding formation, becoming deeper and deeper as it progresses further from the place of submergence.

At the bottom of the map is a sectional view of all the formations found along the Ohio river, from Pittsburgh to its mouth. But as no new formations occur above the mouth of Kanawha river, or below Henderson, deserving of notice, these points are made the termination of the section. The middle part presents a view of the blue limestone, when viewed against the edges of the layers, as it exhibits itself along the banks of the river, above and below Cincinnati. The alternations of the limestone and clay marl are here distinguished, the former being represented by the rhombic parallelograms, the latter by short lines parallel to the planes of stratification.

From this section it will be seen, that the rock of this formation underlies the whole country, and could be reached in every part, by penetrating through those that overlie it; though its depth below the surface increases with the distance from its junction with formation second.

Again, it will be perceived that the uppermost layers at the above point of junction (see section at bottom) are not the same as those at Cincinnati, which is near the middle of the section ; consequently the whole formation must be considerably thicker here than in the middle ; although it is ascertained there to be not less than a thousand feet. At Cincinnati there is no dip ; but at no great distance, in every direction, these are found to dip away from the centre of the formation. The dip is greatest east and west, and comparatively little north and south. This is the reason why the region is so much longer in the latter direction ;—the dip being less, it does not so soon pass under the other formations.

**FORMATION 2.** This is likewise limestone ; but differs much from the former, in its general appearance, its structure, and in color. Its appearance is much more massive ; most commonly lying in layers from a foot to several feet in thickness ; and it is not regularly interstratified with clay, or clay marl, though it frequently has two or three layers of this substance, of great thickness. An instance of these is found in Adams county, Ohio, where one of those beds is twenty-five feet in thickness, and another is one hun-

dred and ajx. Along the banks of streams, where it has been cut through by the water, this rock presents a very rugged appearance, standing in bold, precipitous cliffs, sometimes perpendicular, and sometimes overhanging, ten, twenty, or even thirty feet; which has acquired for it the designation of the cliff rock; a name by which it is extensively known in the region through which it passes. It is this characteristic of the rock, which has given name to the town of Clifton, in Ohio, which stands upon the brink of one of the cliffs. And in Indiana there are two streams whose whole course is in this rock, called Clifty, on account of the great abundance of cliffs on their banks.

This formation is remarkable for the great number of falls and rapids in all the rivers that run through it. Thus the falls in the Ohio river, at Louisville, occur in passing over this rock. The Wabash runs on a naked bed of the same for a hundred miles above Logansport, Indiana, pouring almost continually, in little cascades, over the outcropping edges of successive layers. And almost every river and rivulet in the whole region, over which this rock extends, has more or less of falls or rapids in its course. The great fall of Niagara, pours over the same strata which obstruct the navigation of the Ohio, at Louisville. All this is owing to the peculiar character of the rock in withstanding the wearing action of water.

As a building stone, it is much better adapted to the massive masonry of public works; but on account of the thickness of its layers, it is less suitable for ordinary building purposes. It has less clay in its composition than formation 1, and more sand. In some of the lower layers, there is so much sand as almost to deserve the appellation of sand-stone; but the cement is always calcareous. In some of the upper layers, it presents a peculiarly ragged appearance, where it has been long exposed to the weather, owing to the unequal distribution of its component parts; the sand, when it is feebly cemented, disintegrating, and falling out; which makes the rock full of holes, appearing as if they had been corroded. This portion of the rock makes the best quicklime.

**Fossils.** This formation presents more variety and interest in its fossil remains, than any other in the country; owing to their great abundance, perfection, and size. They are generally much larger, and of more striking and interesting forms, than in formation first, though less numerous. A portion of its fossils are the same as in the latter, but in general they are new species, and often new

genera. Shells are much less abundant, but the radiated animals seem to have existed in great perfection at the time of its formation. The falls of the Ohio, and the region around for many miles, is probably not exceeded in interest by any similar region in the world. Fossil remains in this formation are very unequally distributed; in some places they are almost entirely wanting, while in others the rock consists of nothing else. At Springfield, Ohio, the shell called *pentamerus* and *trilobites*, are found in the greatest numbers. At the falls of Ohio are found large *cyathophylla*, very numerous, *catenipora*, *retepora*, *lithodendron*, *radiata*, &c. In Indiana, a little east of Vernon, is a siliceous layer, apparently the last belonging to this formation, which exceeds any thing else in the whole country, for the abundance of its fossils. Much of the rock is very porous and light; and it is extensively manufactured into mill-stones for grinding wheat, being but little inferior to the celebrated buhr-stone of Paris.

**METALS.** This rock is the great depository of the lead mines of the West. From this circumstance, it is sometimes called *galeniferous limestone*. There seems to be something in the nature of this rock congenial with lead ore, for wherever a vein is traced to its junction with any other, it immediately becomes poor. But no valuable lead mines are yet known to exist in it in Kentucky, Ohio, or Indiana. The principal deposit of lead seems to be in the north-west part of Illinois, and in the neighboring parts of Iowa and Wisconsin. There this formation is eight hundred feet deep, while in the other States it is between two and three hundred only.

Zinc ore is likewise found in considerable quantity in connection with lead.

Copper mines are also numerous in the same region, and it is thought they will prove to be very rich.

Iron, as an ore, is not found in connection with this rock. Small nodules of the sulphuret occur in it, which somewhat injures it as a building stone. Bog ore is found in the northern part of Ohio, and of Indiana, in the region underlayed by this rock; but it has no relation to the rock, as it is found entirely in connection with the overlying diluvium. Calcareous tufa, and stalagmite, are abundantly formed by springs which issue from this rock.

**DIP.** The dip of this formation conforms to that of the preceding, (see section at bottom,) inclining outward, every way except the north, where it is very slight.



**FORMATION 3.** This formation is usually called slate, but sometimes shale. Much of it falls to pieces by long exposure to the atmosphere, and forms a stiff clay. Hence, it is unsuitable for a building stone. Its color is dark brown or olive, and sometimes quite black, owing to the great quantity of bitumen which it contains. It is the most perfectly and evenly stratified rock in the whole country. It uniformly lies in thin laminæ, and will often split out in leaves several feet across, as thin as pasteboard. It is in some respects a most striking formation, particularly on account of its structure and color, which are such that it can never be mistaken for any other; and forms a very convenient landmark for the geologist, in determining the relative position of the other geological formations. Owing to its dark color, and the quantity of bitumen it contains, which renders it combustible to some degree, together with its softness, it has often been mistaken for coal, or an indication that coal was near. Accordingly in numerous instances, search has been made in it for coal; and in this way much capital and labor have been already expended in vain for fossil fuel. What strengthens the deception most, is, its combustibility; for it will readily blaze when thrown upon a brisk fire, though it is incapable of supporting its own combustion. Its bitumen in a few minutes burns out and its color changes to white; and then it appears to be, what it really is, a piece of clay. Some very thin seams of coaly matter, of a few lines in thickness and of very limited extent, have been found in it, which appear to be nothing more than bitumen which has oozed out into some fissure, and hardened by evaporation, or by pressure.

**Fossils.** A single species of bivalve shell, about a quarter of an inch broad, is all the fossil remains I have ever found in it. But above it, or between it and formation fourth, is, in some places, a thick bed of clay marl, which is exceedingly rich in fossil encrinites, or, as the people call them, button-moulds. Here the finest specimens in the country are obtained; both on account of their size and beauty. Being imbedded in clay, they can easily be obtained of considerable length, free from any foreign matter. One of the most noted localities, is about twelve miles southwest from Louisville, called Button-mould Hill. Another still better is near Crawfordsville, Indiana.

**METALS.** Iron is the only metal found in connection with this slate, lying immediately above it, in a bed of iron stone, two feet thick; and large masses or balls of argillaceous iron ore, and of car-

bonate of iron are imbedded in the clay above mentioned. These are found in great quantities at New Albany, Indiana, Bardstown, Kentucky, and Worthington, Ohio. Small cubes and nodules of iron pyrites are also found imbedded in the slate, which by decomposition form copperas and alum, with which all the springs and wells in this formation are impregnated.

**DIP.** The dip is the same as that of the underlying limestone, that is, outward, in every direction; or perpendicular to the line of its strike. It thins out to the west and thickens to the east. It is one hundred and four feet thick at New Albany, Indiana, but in Adams county, in Ohio, it is two hundred and fifty-one, (see section, at bottom.)

**FORMATION 4.** This is sand-stone, often interstratified with shale, cemented sometimes by argillaceous and sometimes by calcareous matter; or both together. Its stratification is remarkably regular; although its layers are frequently of massive thickness. From this formation is obtained the material for all the cut stone, such as stone fronts, columns, and tombstones, used throughout the region which it traverses, and in all the towns along the Ohio, from Portsmouth to Madison. It is easily wrought into any form; and where its cement is calcareous, it is very durable. But owing to the difference in the cement which holds the particles of sand together, it requires to be selected with special care, when it is to be exposed to the action of moisture and frost. When it is cemented by argillaceous matter, it will, in a few years, crumble and fall to pieces. The State of Ohio has had some serious lessons in this matter, in the loss of several hundred thousand dollars, by the premature decay of some of her public works. The great arch over the mouth of Mill creek, below Cincinnati, and many of the locks in the south half of the Ohio and Erie canal, are good examples. Its upper layers contain the best building materials. It is brought in immense quantities from the neighborhood of Portsmouth, Waverly, and Piketon, in Ohio, to Cincinnati, and other places along the river, and sawn out for all the purposes for which cut stone is required.

The breadth of this formation upon the surface, is sometimes from fifteen to twenty miles; but in Kentucky and Indiana, through which it passes, is generally much less.

Its thickness, where crossed by the Ohio river, a little below Portsmouth, is three hundred and forty-three feet; below New Albany, Indiana, it is two hundred and eighty.

**DIP.** The dip is conformable to the preceding formations, (see section at bottom of map.)

**METALS.** No metals of any kind are found in this rock. Bog-iron ore is sometimes found in the overlying soil, but has no geological connection with it; being dissolved and washed out by springs from the conglomerate of formation 6.

**FOSSILS.** This formation, like the preceding one, is barren in fossil remains; though in some places it has a considerable supply of bivalve shells, and small encrinurites. The most interesting locality for these yet known is in the vicinity of Newark, Ohio. In this formation in the West, we first meet with the fossil remains of plants in the ascending order. These are *fucoides*, of the species called *fucoides canda galli*. They are very abundant in some of the rocks quarried at Waverly, and the vicinity.

**FORMATION 5.** We now come again to limestone, and that too of the purest kind, being nearly free both from sand and clay, and is an almost pure carbonate of lime. It is nearly or quite wanting in Ohio, but in the interior of Kentucky and Indiana, and around the southern and western borders of Illinois, and the eastern border of Missouri, it is exceedingly developed. It is almost the only rock found along the Mississippi river from Herculaneum to Quincy, often standing in bold and perpendicular cliffs of several hundred feet in height. It is the only building stone at St. Louis, Alton, &c. It lies in strata of massive thickness, and much of it is exceedingly well adapted to the heavy masonry of public works, on account of the ease with which large blocks can be obtained, and their freedom from cracks or seams. It makes lime of snowy whiteness; and is extensively burned in the neighborhood of Leavenworth, Indiana, and sent down to the lower country on the Mississippi to market. In some places it has a peculiar compactness of structure, breaks very easily, with a smooth, conchoidal fracture, and strongly resembles the kind of stone used in lithography. In other places, it is perfectly oolitic, appearing as if made up entirely of perfectly round grains, about the size of mustard seed; sometimes much less.

This is the celebrated cavernous limestone, which abounds so much in caves or grottoes. No other rock in the West has any caves in it worth mentioning, except formation 2, which has a few of inferior interest. But in this rock nature has played fantastic tricks, in excavating a multitude of avenues of all forms and dimensions, and branching off in endless variety. They did not

always exist, but the process of excavation appears to have been commensured by the corroding action of springs of water, perhaps assisted by some acid, running through the fissures of the rock. And when the passage became thus enlarged, so that water filled but a small portion of its space, the air within seems to carry on the process already begun. This action is more powerful within the caves than just at their mouth, where the rock is in contact with fresh air. For this reason, the entrance of their caves is usually small, while they suddenly enlarge within. They are frequently filled with carbonic acid gas, which renders it dangerous to go into them without proper precautions.

As the enlargement of these caverns progresses, the rock over them often becomes so thin, that it breaks down, and forms deep pits, which the people call 'sinks,' or 'sink-holes.' These are very numerous over all the region underlaid by this rock, and are a great annoyance to the farmer. They are from a few feet only to fifty or sixty feet in depth. Their breadth across the top is uniformly about twice their depth. They are nearly circular at top, and descend on all sides at an angle of about forty-five degrees, until they come to a point at the bottom. Their shape is that of an inverted cone. Not unfrequently a person may pass down through them into the cavern beneath; which usually extends to the right and left to a considerable distance, where he may sometimes travel to his heart's content through these dark and damp subterranean passages without finding any termination.

A few years ago, in Kentucky, one of these caves broke down, and overturned a house, which happened to stand just upon its brink, which was the first notice its inhabitants had of the existence of the cavern that lay concealed beneath them.

The celebrated Mammoth Cave in Ky., is in this rock, in the southeastern part of Edmonson Co.; but this is only one of a thousand, or perhaps of ten thousand, that actually exist within the limits of this formation; though this cavern is more extensive, and on some accounts more interesting, than any others that have yet been discovered. The extent of its various passages which have been surveyed all together amounts to about forty miles; though no person has yet been in it more than twelve or fifteen miles from its mouth.

In this region most of the streams and springs of water sink into the earth, and run a large part of their course under ground, through these subterranean passages in the rock. Sometimes they

suddenly break out and run for a while above ground, and then as suddenly sink out of sight. Hence, in travelling through this region, one is continually hearing of 'sinking springs,' 'sinking forks,' and 'lost rivers.'

The region underlaid by this rock is, in Kentucky, called 'the barrens;' a name that sounds rather forbidding to strangers. But it is not on account of any particular barrenness in the soil that it is so named; but on account of its peculiar appearance in a state of nature. The timber, where there was any, was stunted; much of the land was without timber, except a few scrubby oaks, which seemed to have made an effort to grow, but could not. These were interspersed with shrubs, prairie-grass, and weeds. This gives it a strange, and rather a forbidding air, to those who are in search of a home. But upon cultivating the soil, it is found to be at least of medium quality. Much of the same character and appearance holds throughout this formation; though it is less conspicuous in the other States through which it passes.

The singular appearance of this region is certainly caused by the peculiar character of the underlying rock, for it always disappears immediately on passing on to another formation; but in what way it is not easy to tell. Some have supposed it is owing to the great number of caverns in the rock, into which so much of the water and moisture of the soil sinks, as to deprive it of a sufficient quantity to support a vigorous vegetable growth. But I have bestowed some attention to this matter, and do not think that the caverns are sufficiently numerous to warrant such a conclusion.

Another cause has been assigned. There is scattered over a considerable part of this region large quantities of flint or horn-stone; sometimes lying in large lumps over the fields, which strongly resemble in their structure the French buhr-stone; in other places, it is compact, like gun-flint, but broken up into small fragments having sharp and cutting edges, and appearing exactly like the cast-off fragments in the manufacture of gun-flints, or of Indian arrow-heads. These are so numerous in some places, that it is impossible to plow the ground. Some have supposed that these flints have caused the peculiar appearance of this region. But this must be a mistake; for there are many places where they are entirely wanting, and yet 'the barrens' are as conspicuous as ever. Others have supposed that they have been produced by the fires of the Aborigines, which they caused to run through this region to drive out the game that was lurking in its hiding-places.

And they have adduced the stunted appearance of the timber to show that its growth has been prevented by their fires. But this cannot be the reason, for the same kind of timber does not grow any better now the fires are kept out; scrubby oaks will be scrubby oaks still. If fires have produced 'the barrens,' why should they stop immediately on coming upon any other formation? It would be in vain to look for barrens or scrubby oaks in any part of the West, that is not underlaid by the rock of this formation.

**DIP.** The dip of this formation is conformable to that of the preceding; that is, to the West and South, in Kentucky and Indiana; and to the East and Northeast in Illinois and Missouri; or perpendicular to the direction of its strike. Of course, its form in the earth resembles the bottom of a lake or sea; coming to the surface at the edges, and dipping down to a considerable depth in the middle.

**METALS.** Iron is exceedingly abundant in this formation in Tennessee; but in the States represented on this map it is not found in much quantity. Lead ore is found in it, in several places, near the Cumberland river in Kentucky, and in the South part of Illinois. A considerable proportion of the lead mines of Missouri are in this formation.

**FOSSILS.** In general, fossils are scarce in this rock; particularly shells; but in some places encrinital joints are exceedingly numerous; indeed, they seem to constitute almost the whole rock. Most of them are very small; countless myriads of them are of microscopic littleness. But the most interesting fossil found in it is the Archimedes, so called, because its form resembles the famous screw invented by that philosopher. Dr. Troost, the geologist of Tennessee, considers this fossil to be an unfailing indication of the commencement of the coal series.

**FORMATION 6.** This formation is called conglomerate, or pudding stone, and consists almost entirely of pebbles and coarse sand, of white or milky quartz, cemented together by a paste of the same material. In some parts of Ohio, it consists of coarse pebbles and sand, mixed together; in others, as in Rockcastle Co., in Kentucky, they are nearly uniform in size, of the bigness of peas; while in others, as at Leavenworth, in Indiana, it is a coarse sandstone. But the material is every where the same, and it is generally more or less stained with oxide of iron. In several places it is manufactured into mill-stones for grinding corn, for

which it answers a good purpose. In others, where it takes the form of a coarse sand-stone, it makes a good building material, especially for heavy masonry. The locks on the Ohio and Erie canal are made of it, from Cleveland to Newark, in Licking Co. But in most places its stratification is so imperfect and irregular, and the material so coarse, that it is unfit for building.

**DIP.** This may be seen in the section at the bottom; only its direction will change with that of its outcrop or strike, being always perpendicular to it. Its thickness, where the Ohio river crosses it, in Scioto Co., is about eighty feet; but in some places it is thinner, while in others, it is two or three hundred. Its thickest part is towards the northeast.

**METALS.** No metals of any value are found connected with this rock.

**FOSSILS.** This formation is barren in fossil remains; and this is not to be wondered at; for the tumultuous state of the waters, which was necessary to round so many pebbles, and to transport them so far as these must have been transported, must have been fatal to every sort of living thing within them. In some places fossil plants are found, or rather the stems of plants, but their appearance clearly shows that they did not grow in the places where they now are; but that they have been swept along by the same current that transported the beds of sand and gravel which now constitute the rock of this formation.

The first three formations, and the fifth, are entirely destitute of fossil plants; the fourth has both plants and animals; and the sixth has plants only, which entitles it to rank as the commencement of the coal series.

From the dip of all these rocks, and from the manner in which they lie in the earth, it will be perceived that each successive formation, in the order in which they have been described, rests upon the preceding, and consequently is newer. Each one must have been deposited and completed, except the hardening process, before the succeeding one was commenced. Accordingly, the circumstances of the earth, and the sources from which the ocean derived its supply of matter for these formations, must have been very different. This gave rise to the great diversity in the kind of rocks in these several formations, and to the growth of different kinds of organized beings. At one time shell-fish and other marine animals only existed, and during these periods limestone was chiefly formed.

At other periods shale and sandstone were the principal rocks formed, which favored the growth of plants. It was during these periods that these immense beds of coal were deposited, which form one of the most striking characteristics of the West.

**COAL SERIES.** Immediately on passing over the conglomerate from the older formations, we begin to meet with coal. But it would be useless to look for it in any of these which have been described. They are all older than the coal, as is demonstrated by their dipping beneath it. They are geologically lower than the coal formations. It is a fact which is not generally known, except to geologists, that all the workable coal-beds were formed at a particular period of the earth's history, and that all the coal-fields in the world are of one age, or were in the process of forming at the same time. I do not mean that they were formed in one year, or in one thousand years, or any other definable number of years for the term years does not enter into the reckoning of the geological calendar.

Geological time is reckoned by periods, which to us is altogether indefinite; but each of which was undoubtedly of very great length, according to our ideas of time. It was during one of these periods that coal was formed, and only one. Hence this is called the carboniferous period. The coal-fields of Europe, then, or of any other part of the world, are of the same age as those of the United States, or were in the process of forming at the same time.

All the rocks in the world are divided into three great classes; the primary, the secondary, and the tertiary. The secondary being very numerous, are divided into two nearly equal divisions, called upper and lower secondary. It is in the upper secondary where coal is found. The lower secondary abounds more in limestone and less in sandstone and shale than the upper; while the latter abounds less in limestone, and more in sandstone and shale. These last are the principal rocks found in connection with coal. Coal is never found in countries or regions where limestone is the principal rock. If this fact were generally known and heeded, it might have prevented the waste of considerable capital and labor.

There are two great coal-fields in the West, one of which is wholly included within the limits of this map, while it embraces but little more than half of the other. The latter lies in the south-



eastern portion, including a part of Pennsylvania, Ohio, Virginia, and Kentucky. The former lies chiefly in Illinois, including also large tracts in Kentucky and Indiana, and small portions of Missouri and Iowa. There is also another large coal-field lying in the western and northwestern part of Missouri and the country beyond, but its limits are not yet very accurately known. There is another in Michigan, a small portion of which appears on the upper edge of the map. Within these limits coal might probably be found every where, though not every where with equal ease; but out of them it would be in vain to search for it; for a large portion of the rocks are limestone; they belong to the lower secondary, dipping under the coal, and consequently are geologically too low for coal.

The whole coal series is made up of various combinations of thick beds of sandstone and shale, with comparatively thin beds of limestone, hornstone, iron ore, and coal. The manner of their arrangement will be best understood by the section at the bottom, and likewise all the other sections. The coal-seams are represented by the large black lines. But the number of coal-seams, as well as of the other rocks with which they are connected, is really much greater than is represented in the section. In the central portions of the field, there are said to be about thirty seams of coal, though about half of them are too thin to admit of being worked.

DIP. The different members of the coal series lie upon or within each other, like a succession of shallow plates of crockery, constantly diminishing in size from the bottom upwards. Consequently the dip in every part of the field is from the outer edge towards the centre. This is demonstrated from the fact, that all the seams become deeper in the direction towards the centre of the field, disappearing under the beds of the rivers, and cross out into the opposite direction. It is supposed that the lowest coal-seam which crosses out and caps the tops of the hills along the borders of the field, has been reached at Pittsburgh, which is near the centre, in boring for salt, at the depth of nine hundred feet below the river; and adding five hundred, for the height of the hills, would make the amount of its dip from its out-cropping to the centre of the field, fourteen hundred feet. Now, Pittsburgh is situated between forty and fifty miles from the borders of the field; the average rate of the dip must therefore be a little over thirty

feet to the mile, which corresponds with actual measurements. But this is so very gradual, that it is not distinguishable by the eye from an absolute level; and can only be determined by actual measurement, or by observing which way the water runs on the floor of a coal-mine, or by tracing a particular seam for a considerable distance. In these Western States, the mining of coal is exceedingly easy, being commenced on the side of a hill, where the seam crops out, and a passage, called a 'drift,' made into the hill, following the direction of the seam, about ten feet wide. These passages are continued for great distances, from which others are made to branch off in various directions, until an almost inextricable labyrinth or artificial cavern is created, somewhat resembling the Mammoth Cave in the extent of its tortuous windings.

Sometimes two or even three workable seams of coal make their appearance in the side of one hill at different heights; and mining is carried on in them all at the same time, like the different stories of a house; there being between them thick beds of sandstone and shale, commonly with thinner beds of some other rocks. The sandstone of the coal series commonly has mica in it, whereas that of formation fourth seldom or never has. The former has a sharp grit, and is worked extensively into grindstones, the latter is commonly too fine and compact; though there are places where it is excellent, as at Berea, twelve miles southwest from Cleveland, in Ohio.

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## OF THE METALS AND OTHER USEFUL MINERALS.

Many of the most useful substances belonging to the mineral kingdom are found in the West in the greatest abundance; and as they are generally found connected with some particular formation of rock, a few remarks concerning their localities may be useful.

**IRON.** The most extensive and useful deposit of iron, is in the coal-field which surrounds Pittsburgh, consisting of a layer, from two to four feet in thickness, lying between the first and second layers of coal. Of course its out-cropping will be near the borders of the field. (See the narrow iron red line in section at the bottom.) Here may be seen already an almost unbroken line of

iron furnaces in that part of Ohio through which its out-crop passes, and extending in Kentucky, through Greenup, Lawrence, Estill, and other counties, where it is now extensively worked, and will be much more so in a few years. It is probable, also, that the same or a similar bed of iron ore exists in the other great coal-field to the West, as a considerable number of furnaces have already sprung up in Indiana, and in Kentucky, in the same geological position; that is, just within the borders of the coal-field. But as the country is here newer, its resources are yet but little developed, and consequently less known. It is a most happy circumstance for the country, that this valuable and extensive bed of iron ore is situated in such close proximity to some of the most valuable seams of coal, so that it commonly happens that the same bank or side of a hill furnishes both the ore and the coal necessary to its reduction.

There are several other geological connections in which iron is found in the West, but less continuous and extensive; being subject to frequent and sudden interruptions, or rather existing only in patches through their respective formations. This is the case with formations third and fifth.

But the most wonderful locality for iron in the West, or perhaps in the world, is in the State of Missouri, in a region lying a little to the west of Potosi, in Washington Co. It is in the primary rocks, the only ones found in any part of the country represented upon the map, where they have been upheaved through the secondary, which underlie all the surrounding country. There is an extensive region that is filled with iron ore, but there are two localities or rather hills of iron ore in this region deserving of particular notice. One is called the Iron Mountain, the other Pilot Knob. The former is about one mile wide, three miles long, and about three hundred feet high, and is nearly a solid mass of the micaceous oxide of iron. The other is much larger, being about seven hundred feet high. Nothing in the mineral kingdom perhaps in the whole world, would strike the beholder with greater astonishment than to stand upon one of these eminences and behold the immense body of ore beneath and around him. He could not avoid the feeling, that the quantity is sufficient to supply the wants of the world. But there it lies, and there it must lie, until the increasing wealth and population of the surrounding country shall furnish the occasion and the means for its use.

**LEAD.** The West may challenge all the world in the production of lead. This mineral is here exclusively connected with the limestone formations; chiefly with the second and the fifth. The principal lead region lies in the vicinity of the Mississippi river, extending from the vicinity of the Iron Mountain to that of the Northwest corner of the State of Illinois. As yet it is principally mined in the counties of Washington, Jefferson, Madison, and St. Francis in Missouri, and in the region to the North and Northwest of Galena, in Illinois, Iowa, and Wisconsin. Lead veins have also been found in Kentucky in several places, and in the South part of Illinois, which in general are small; but some of them may be found sufficiently rich to admit of profitable exploration.

**ZINC.** This mineral is likewise found in large quantities, and always I believe in the West in connection with lead.

**COPPER.** The ores of copper are found in inexhaustible quantities in Franklin, and in some of the neighboring counties in Missouri; and perhaps equally so, within and north of the lead region of Iowa and Wisconsin. It is also found in Randolph Co., in Illinois, but it is not known to what extent, as it is not yet worked.

**SALT.** Great quantities of salt are made in the West from salt water, which is obtained by boring or drilling through the rocks in the coal-fields. There is no other part of the country, probably, where it can be obtained in sufficient quantity for the manufacture of salt but in the coal regions. These borings are extended down to a depth from two hundred to twelve hundred feet deep. And where salt water is reached, it generally rises to the top immediately, and flows over in a constant stream.

But it is not supposed there is any body of salt water at this, or any other depth, from which this flows; but that it is in the rock, forming a constituent part of it, or rather filling up the interstices between the particles of which it is formed. For it is almost universally obtained from the sand-stone of formation fourth. And where the water is obtained, the rock appears to consist almost entirely of clean white sand, with very little filling up except the salt water, and through which it percolates with freedom. But

there is no brine of any value in these rocks, where it comes to the surface, or even within several hundred feet of the surface. It is only at such depths as mentioned above, that it can be obtained of sufficient quantity and strength to answer the purposes of manufacturing.

The most probable reason for this, is, that the specific gravity of the brine has caused it to sink away from the more elevated portions of the rock, to those that are lower; and that the constant percolation of fresh water from rains, through these upper portions, would wash down all the remaining saltiness into the common reservoir. This view of it seems confirmed, by the fact, that the deepest wells, as they are called, or those situated where the rock is deepest below the surface, generally furnish brine in the greatest quantity, and of the greatest saltiness. Although this formation underlies a much greater extent of country than the coal-fields do, under which it passes, and though it has no geological connection with them, yet it is found that no valuable salt wells can be obtained without the limits of the latter, because its depth below the surface is not sufficiently great. It is deepest under the centre of the coal-fields, and consequently it is there where the greatest quantities and strongest brine may be expected.

The greatest place for manufacturing salt in the West, is in the vicinity of Charlestown, on the bank of the Kanawha river, in Western Virginia. Several millions of bushels are manufactured here annually; and the salt is taken down the river into the Ohio, in flat-boats, which float upon the current, and delivered at all the towns situated upon its banks, and upon the lower Mississippi.

Great quantities are also manufactured on the Muskingum river in Ohio, particularly in the vicinity of Zanesville. More than fifty salt-wells or borings have been made in Muskingum county alone, which produce on an average, about five thousand bushels of salt annually. Many borings have also been made in Athens, Morgan, and other counties, with similar success, both in Ohio, and in western Pennsylvania.

Salt-making has also been extensively carried on, for many years, near Shawneetown, in Illinois. And within a few years operations have also been commenced within the borders of the coal-field of Indiana. The water obtained at all these wells is much saltier than the ocean, requiring only about forty or fifty sometimes sixty gallons for a bushel.

**GYP SUM.** Gypsum, or plaster, as it is commonly called, is found in considerable quantities on the point of land extending between Sandusky Bay and Lake Erie. It is likewise found in great quantities at the rapids of Grand River in Michigan. Besides these two places, gypsum is not known to exist in quantities sufficient for economical purposes.

**COPPERAS AND ALUM.** These salts can be made in any quantity, from the slate of formation third, and from almost all the shales in the country, by breaking them up and exposing them, for a considerable time, to the combined action of air and moisture; during which time the iron pyrites which they contain undergo a chemical change, and, together with the alumine of the rock, form the salts in question. They are also found, already formed, in considerable quantities, on the sides of hills, and banks of streams, where the rock is exposed to the weather, sometimes shooting out in a multitude of small crystals, like frost.

**SALTPETRE.** This abounds in almost all the caves in formation fifth; seldom any where else. It is, however, not a true saltpetre, (nitrate of potash,) when first found, but a nitrate of lime; and has to be changed to the nitrate of potash, by leaching it through wood-ashes, when the nitric acid leaves the lime, and unites with the potash of the ashes.

A mixture of this false-saltpetre and gypsum is found in many of these caves, particularly in the Mammoth Cave, which shoots out into long and slender crystals, sometimes of a foot or more in length, and bent into every variety of shape.

**MINERAL SPRINGS.** These are numerous in all the western states. Chalybeate springs are very common in Ohio and Indiana, in formations second and third. The Delaware springs in Delaware county, and the yellow springs in Green county, are the best known, and where large and elegant establishments have been erected for the accommodation of visitors, during the sultry months of summer.

In Kentucky, there are numerous springs in formation first; the principal of which are the 'Blue Licks,' about twenty-four miles back of Maysville; 'Drennen's Lick,' near the west bank of Kentucky river, twenty miles from its mouth; and the Big Bone Lick,

two miles from the Ohio river, near the line between Boone and Gallatin counties. They are nearly alike in the quality of their waters, which contain a variety of mineral ingredients, among which, common salt, copperas, and sulphureted hydrogen gas are the most conspicuous. The water in them is uncommonly transparent at first, and afterwards deposits a black sediment, like ink in appearance.

In formation third, there are also Epsom springs in this State, or springs strongly impregnated with sulphate of magnesia. They are in the southeast part of Lincoln county.

In the coal regions of Kentucky, there are a number of springs, upon the surface of which there floats a considerable quantity of oil, or something that has the appearance of oil. It is probably petroleum, and is derived from the bitumen of the coal, through which they run. It is used for medicinal purposes. The most remarkable spring of this kind known, is about six miles from Owenton in Daviess county.

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### AGRICULTURAL GEOLOGY OF THE WEST.

Much is said, and truly said, of the great fertility of the West; and but little of the causes which have produced it. Because it has, while new, yielded the most abundant harvests, with but little labor, it will not do to presume that it always will. Like most other friends, it will sooner or later become exhausted by always giving and never receiving; and if taxed too severely, without some remuneration, its friendship may be changed to coldness, indifference, and even hatred; or, in other words, its fruitfulness, which has been so much boasted of, may become barrenness.

Now for every thing there is a cause; and, of course, there is a cause for the uncommon fertility of this country. And when that cause is understood, we are better prepared to supply deficiencies, and avoid mistakes, than when we are ignorant of every thing but the fact that things are thus and so. Many have an idea that book knowledge is of no use to a farmer; his field, they think, is his book, from which all the knowledge that will be of any use to him in filling his granaries, is to be derived. But those who reason in this way, are not aware that there are two sides to the question; one of which only they have studied, while they have

neglected the other. They have studied how they shall get the greatest possible amount of produce from their soil this year; without reflecting, that, speaking after the manner of men, it has a right to expect something of them in return, after a while. Always giving and never receiving will in time exhaust the most ample wealth. The soil can no more give to us, from year to year, its stores of produce, without something in return to restore its exhausted fertility, than we can be always giving, and never receiving, without coming to poverty. Therefore, if farmers, even in the West, expect their fields to continue to yield them their wonted abundance, they must know that their duties are reciprocal; that they must furnish them with the proper nutriment, when their original stock becomes exhausted. This is a lesson, which most of the farmers in the West have yet to learn. The sentiment expressed by Solomon, whatever may have been its original design, is very appropriate here: 'There is a giving that maketh rich; and there is a withholding more than is meet, and it tendeth to poverty.'

Fertile as this country is by nature, it is capable of being made much more so by art, at little expense. And for the want of this art, or rather of the knowledge of the right method of applying it, much of the land, in the older settlements, has greatly declined from its original productiveness, and some of it has even been abandoned as useless, which, thirty or forty years ago, was equal to any in the country. In the language of the owners, 'it is worn out.' And many have sold their farms, and moved off to newer parts of the country, on this account. Well, it is an unalterable law of nature, that every thing, both animate and inanimate, shall 'wear out' by use, unless there is some way of supplying the exhaustion to which it is subjected. How long would it take a horse to 'wear out,' if he had to work all the time, without any thing to eat?

Now, Mr. Farmer, there is more analogy between a horse and a plough-field than you may imagine. I suppose you keep your horse in good condition, by giving him food and drink every day. But you have worked your plough-field, and carried away the whole of what it has produced, for twenty or thirty, or even forty years, and have never given it one morsel! And is it strange that it is worn out? I think it strange that it did not wear out a great deal sooner than it actually did. A farm that is properly treated will never wear out, but, on the contrary, will increase in



productiveness. It is a shame for a farmer to talk of his land wearing out; the very expression ought to make him blush; it shows that he either does not understand that part of farming which consists in repairing the constantly wasting fertility of his soil, or that he has been too indolent and reckless to attend to it. The native fertility of the West is so great, that for the first few years it really does not need much aid from art to make it more so. But this fertility is not inexhaustible. By constant cropping without manures the choicest lands may be converted into a barren waste. The once rich and fruitful fields of Palestine, by this means, are now little better than a desert. It is said that the geological formations of that country are exactly the same as the limestone districts in these states. And here the same process of depreciation in its soil, especially in Kentucky, which has been longest settled, has in many places made fearful advances.

But by practical repentance and reformation, its exhausted fertility may be restored, and these parched fields may again be made to flourish and blossom as the rose. A noble spirit of improvement has, for a few years past, been manifesting itself; and I doubt not, that it will, ere long, restore to these exhausted lands their pristine vigor. This may be done, with much less labor and expense than is necessary to clear up a new farm; as has already been practically demonstrated in numerous instances. A few years since an Englishman came into Kentucky, and bought one of these 'worn out' farms. The owner thought himself fortunate in getting rid of it at a moderate price, and moved away to a new country. When a few years had passed away, he returned to visit his old friends and acquaintances, and when he saw his old farm, he expressed his utter astonishment at the thriftiness of every thing upon it. Its new occupant saw that it had been exhausted by much tillage and no manure; and for the first two or three years, he took little or nothing from it, but restored to it the whole of its produce, by ploughing it into the soil, while in a growing state, and thus paying back the long arrears of indebtedness to it, which its former tenant had incurred by always receiving, but never giving any thing in return.

**ORIGIN OF SOIL.** There are doubtless many who never thought of asking themselves the question, what is soil made of, or how is it made? or whether or not it has always been just as it is now. But a very little acquaintance with this subject will show us that

it consists of two kinds of matter, namely, mineral and vegetable, and that nature is constantly making new additions to both, to supply the waste that is constantly going on. The mineral matter in the soil, which constitutes much its greatest portion, is furnished by the decay of the rocks that lie upon and near the surface; that is, those that underlie the surface. This decay is effected by the combined power of frost, air, moisture, and other chemical agents. The other ingredient in soil is furnished by the decay of vegetation. In each of these two classes, there are several kinds of matter necessary to produce a good soil. For instance, in the mineral portion, it is indispensable that there should be silex, or sand, alumina, or clay, lime, and iron; and there are commonly several others. Now any one of these alone will not make a soil upon which any thing will grow. If it were all silex, or sand, it would be so porous that it would not retain moisture enough to nourish vegetation; of course it would wither and die. If it were all alumina, or clay, it would be so clammy, and retain so much water in wet weather, as to drown out the vegetation; and in dry weather, it would bake so hard, that it would be equally fatal to vegetable life. The result would be similar if any other kind of matter were to constitute the whole of the soil. Manure itself, which has such fertilizing powers where properly combined with the soil, is barren when alone. Nothing but mushrooms will grow on a dung-heap. So it is, that the proper materials, united together in the proper proportions, and properly mixed, only can constitute a soil of the highest degree of fertility. It is seldom that any soil in its natural state contains all the requisite materials in the proper proportions; and it is the business of the intelligent farmer to find out what things are most abundant in his soil and to improve upon nature, by adding to those which are deficient. For the want of this kind of knowledge, there is often much waste of material, time, and labor, even where attempts are made to improve the soil. For instance, stable manure may sometimes be put upon ground with little or no beneficial effect, because it might not have been in want of any more of that article. Gypsum, or plaster, which sometimes produces the most astonishing results, for a similar reason, at other times, produces none at all.

Sometimes a soil is unproductive, while it possesses all the requisite materials in good proportion, on account of its lying in such a manner as to be too wet or too dry. The remedy for the

former, then, would be, draining; and for the latter, the addition of more alumina or clay, to make it retain more moisture.

Soil, in its natural state, when it is covered by spontaneous vegetation, has the means of administering to its own fertility by the decay of the vegetable matter that grew upon it. But when it is cleared up, and robbed of its native forests, it is entirely deprived of this source of constant renovation. And as it is now made to yield its increase for the benefit of man, it must be compensated for these losses which it has sustained for his sake, or it will withhold its products, and visit upon him a just retribution for the robberies which he has practiced upon it.

From the remarks just made about the decay of rocks, it will be seen that the kind of soil in every country, will greatly depend upon the kind of rocks which lie beneath it, and from which it has been derived. If, for instance, the underlying rock is sandstone, its decay will produce a sandy soil; and it will often be necessary to add clay to it to make it sufficiently retentive of moisture. But on the other hand, if it is slate or shale, its decay will produce a stiff, tenacious clay impervious to water, and will consequently be too wet. The best remedy in such a case will often be the addition of sand to make it sufficiently porous to drain off the superabundance of its moisture.

The limestone of formations first and second, contain large quantities of siliceous, aluminous, and iron, as well as of lime. Consequently they have the elements of a first rate soil, as that of the whole region under which they lie abundantly testifies, in the evidences of thrift and plenty which the traveller sees on every hand. Few other rocks in this, or any other country, are capable of forming a soil of such fertility. Taken as a whole, it is the choicest portion of that highly favored land. This may be demonstrated by the density of its population, and the unexampled growth of its numerous towns and cities.

These two formations occupy nearly equal portions of Ohio, Indiana, and Kentucky, and have produced a soil, which has more uniform fertility and ability to sustain long continued cultivation than any other region of equal extent in that whole country or perhaps in the world. But there is a difference in the soil of the blue limestone (Form. 1.) and that of the light-colored (Form. 2.); the former being the better of the two.

Throughout this formation, the soil is of the richest kind, and of easy cultivation; and the evidence of universal thrift and plenty

which the traveller sees on every side, demonstrates to him, that he is in one of nature's most favored spots. It was the uncommon richness of the soil of this region, together with its beautiful and gently variegated scenery, that drew the attention of the early settlers, particularly those of Kentucky. Here they clustered together, and so long as land within these limits could be obtained, there were very few that were willing to locate themselves any where else. And its superiority over the soil produced by any other formation in the West, is no less manifest now than it was then. And whoever travels over this region, and compares the appearance of its soil, its scenery, and the condition of its inhabitants, with that of any other part of the western country, especially the southern half of it, will be compelled to acknowledge that it was no boasting when these early settlers gave it the appellation of 'Garden Spot of the West.' This is the origin of the phrase, and it is principally confined to the limits which I have laid down as the boundaries of formation first.

It is not to be supposed that they had any knowledge of the cause which produced this difference; but they were judges of a good soil; and the fact that there is to this day such a sudden falling off in the density of the population, and the character of the soil, on approaching those formations that lie around it, is one of the most striking manifestations of the fact, that the geology of a country determines, in a great measure, the density of its population, and the condition and pursuits of its inhabitants.

If we include with this, that portion of formation second which lies in Kentucky, which together constitute only about one tenth of the superficial contents of that State, we shall here, in this comparatively small region, find nearly one half its inhabitants, and fully half the wealth of the whole State. And further, as an evidence that geology has a visible effect upon the intellectual condition of a country, we find in this small portion of the State, about seven collegiate institutions, while there are but two or three in all the remainder. The wealth which the exuberance of its soil has produced, has brought with it refinement and the desire for intellectual improvement.

**SOIL AND SCENERY OF FORM. 1.** The soil produced by the blue limestone, exceeds that of any other in the country, in its strength, richness, and uniform fertility. It is, in general, eight or ten feet deep over the rocky pavement of limestone layers that lie be-

neath, entirely free from stones, or any thing to molest the plough. In its southern part in the interior of Kentucky, it is not quite so thick, and in some places the naked rock makes its appearance at the surface. But this is owing principally to long continued cultivation in situations liable to be washed by the rains.

There is scarcely such a thing as a foot of waste land throughout its whole extent. The highest portions of the region are the most level. The only hills are upon and near the banks of the streams, and have been wholly produced by the wearing down of their beds by their current. Very few of the hills are so steep as not to admit of being ploughed from top to bottom; and there is very little difference in the soil, whether high or low, or upon the sides of the hills. The latter, however, if kept too much under cultivation, will wash and become poor. For this reason they should be kept much in grass.

The 'bottom lands' along the rivers are an exception to the above remark, being somewhat richer than the others.

There is in this formation a remarkable resource for the improvement of its exhausted fertility, when these lands shall require a dressing of mineral stimulus. It consists of the beds of clay marl which are interstratified with the limestone; and which will in future time furnish, within every man's reach, an inexhaustible supply of calcareous manure. But to a person unacquainted with this substance, nothing would be supposed to be further from possessing any fertilizing properties. It has the appearance of blue clay; and to talk of putting this upon a soil, which is already highly aluminous, would, by most persons, be received with a feeling of incredulity, if not of entire disbelief. But it is really lime united with a portion of clay, in a finely divided state, and already prepared for the use of vegetation, without the trouble and expense of burning. An incident occurred a few years ago in my own experience, which first drew my attention to the subject, and caused me to investigate it further. I had a well dug, which of course extended down through the soil, into the strata of limestone and marl; or as the well-diggers term it, soapstone; from which a considerable quantity of this substance was thrown. But supposing it would be injurious to the surrounding soil, if it should get mixed with it, for the purpose of a garden spot, for which I designed it, I was careful to keep it together around the well, until I should have time to remove it. But it remained there over one summer, and I was astonished in

observing that the vegetation which grew up through the edges of this mass, grew to double the size of those which were at a little distance from it. Still it is doubtful whether the full effect of this fertilizer would be generally realized, unless it is mixed with vegetable or animal manure.

It may seem strange to those who are accustomed to a soil composed of the primary rocks, to learn that the soil of this whole region is suitable for making brick. But such is the fact. I never saw any portion of it that would not; and there is very little difference in the quality between one place and another. No man ever thinks of selecting a place to make brick, except with reference to his own convenience. Whenever he wants them, he makes them from the soil on the spot. He never digs down to obtain a better material, for the top of the ground, to the depth of two or three feet, is the best.

There is one idea that will be very apt to occur to the reader in this connection, in reference to the character of the soil in this region, and that is, the fine prospect we have for *mud*, in rainy weather. All the roads, except such as are McAdamized, are a perfect mortar-bed, already sufficiently worked for the use of the brickmaker. But there is hardly ever a bitter without a sweet; for these roads, through which the traveller in the winter and spring, can, with much labor, make out to wallow, at the rate of about two miles an hour, are the finest imaginable in the summer and fall.

**PRODUCTIONS.** The crops to which this region is best adapted, are Indian corn, hemp, tobacco, grass, and fruits. In these articles it may challenge competition with the world. And it is not to be understood that other articles will not grow in it; or that they will not grow well. I mention only such as particularly excel. Wheat grows as well here as any where, but is rather more likely to winter kill than in some other parts of the country, owing to the highly argillaceous character of the soil. It is not quite as certain a crop as it is among the sandstone and shale soils of the coal regions.

**SOIL AND SCENERY OF FORM. 2.** The soil and scenery of the regions underlaid by this formation, differ but little from those of the preceding. The sides of the hills are generally much steeper, often perpendicular; of course, the scenery is sometimes grand, approaching to sublime. The soil is lighter colored and rather more inclined to be heavy. But the productions are the same, and

do not differ essentially in quantity. The forests of these two formations are composed chiefly of various kinds of oak, poplar, or white wood, and sugar-maple; and in smaller quantities of beech, ash, sycamore, hackberry, and black and honey locust.

**SOIL OF FORM. 3.** This produces, in general, a heavy soil, from the too great proportion of clay which it contains. But it is not a bad soil; and in some places, where it has received a proper mixture of sand from the destruction of the overlying sandstone, it is excellent. It is every where well adapted to grass; and the hay business will be likely to be the most profitable to the farmer, when the vegetable mould of the newly cleared land is exhausted, and its resources are fully developed. Although it will produce any thing put upon it, yet it will never equal the limestone soils above described. The scenery throughout this formation is remarkably uniform and monotonous, and the surface is flat. This circumstance, with its clayey soil, causes it to be wet till a late period in the spring. The forests consist principally of white oak, poplar, and beech.

**SOIL AND SCENERY OF FORM. 4.** This region is a perfect contrast to the preceding, in its general appearance and scenery. It is as remarkable for hills as that is for the want of them. The traveller meets with a constant succession of up hill and down, unless when he is winding along the bank of some stream, to avoid their ascent. These hills are steep, and often precipitous; and many of them stand isolated from any others, in shape like a steep mound. These have not been produced by upheavals, for their strata are apparently horizontal, but by the erosion of the rock by air, water, and frost, which has carried it away in some places, and left it in others.

Its soil is poor and thin, unless where it happens to be mixed with that of some other formation. (These remarks apply chiefly to Kentucky, and the southern part of Ohio and Indiana.) A person may travel from the central part of formation first to the east, to the west, or to the south, and he cannot avoid meeting with it, and when he does, he will find it to be true, as the people call it, 'the wilderness.' Though he will find a sparse population, but with every evidence of unthriftiness, except here and there a farm upon some river bottom, or where a combination of favorable circumstances has produced a fertile spot.

I know not to what kind of grain it is best adapted, unless it be rye; as very little of it is cultivated except where it is mixed with a liberal share of soil from some other source.

There is one thing that constitutes a very striking feature of this formation, in almost every part of the country through which it passes; and that is, the growth of pine timber. One may search in vain for a single pine tree over any part of the formations already described; and the moment he comes in sight of the range of hills, or as they are more appropriately termed in their vicinity, 'the knobs,' he will find pine to constitute the most conspicuous part of the forest. And when he sees its dark green foliage in the distance, he need not be at the trouble of going to it to see what kind of rock it stands upon; he may take my word for it, that it stands upon the sandstone of formation fourth. The principal timber of any value besides pine, is oak and poplar, and these are not abundant. But there is here an enormous quantity of underbrush and shrubs; so much so, that it is frequently difficult for a person to penetrate through the forest.

**SOIL AND SCENERY OF FORM. 5.** The soil of this region cannot be considered as first rate; neither is it of inferior quality. But almost the whole of it wears such a strange appearance in its natural state, such a look of barrenness stares upon the beholder on every hand, in the stunted appearance of its vegetation, and in the almost nakedness of many portions of it, that a stranger would at once judge it to be a region doomed to perpetual sterility and loneliness. But he would soon find himself agreeably disappointed in meeting with fields of waving grain, and every thing necessary for the sustenance and comfort of man, where the hand of culture has been applied. Its effect has been wonderful; it has dispelled the haggard appearance of its natural state, and changed these 'barrens' into fruitful fields. It produces respectably almost every thing raised in any part of the country, and the farmer feels himself satisfied for his toil, in the harvest which he reaps. Almost the whole region is either destitute of timber in a state of nature, except scrubby oak, or is thinly covered with oaks of other and more valuable kinds. Very little other timber grows upon it.

The scenery is agreeable and diversified, much resembling that of formation second, except in its barren appearance when in the natural state.



**SOIL AND SCENERY OF FORM. 6.** The strip of country through which this formation passes is so narrow, and the soil which it has produced is so much mingled with that of other rocks, that there is no very settled character to it. It is, however, hilly and broken, somewhat like formation fourth; but the hills have a different appearance in regard to their shape, owing to the different manner in which the rock disintegrates; so that they can generally be distinguished from the others, to the distance of several miles, in the general contour of their outline. The rivers running through it, often have very high, steep, and craggy banks, and the water not unfrequently leaps from a considerable height down some perpendicular precipice, which together give the region a highly picturesque appearance. But as this rock is considered as belonging to, and the soil which it produces so much resembles that of, the region underlain by coal, I shall embrace all further consideration of it under the head of

**SOIL OF THE COAL SERIES.** The rocks of the coal region are composed mostly of grits and shales; and the transition from one to the other is so frequent, and their alternations are so numerous, that the soil throughout is generally made up of a mixture in various proportions of these two elements, together with smaller quantities from such other rocks as happen to occur among them. There are here all the necessary elements of a first rate soil; and where the combinations of all these materials are in due proportion, there is evidence visible, in the luxuriant fields of waving grain which they produce, of its truth.

But as sandstone alone produces a soil that is too light, and shale alone one which is too heavy, these two extremes are not unfrequently met with, and that too in close proximity. There is therefore no such uniformity here as in the other formations. There will be found here, therefore, every variety of soil that exists in all of them, from the best to the worst. There can here be no such general guide, as there, in the selection of land. Actual examination alone can determine its character.

It can hardly be expected, from the representation here given, that any particular products will become staples in this part of the country. For where such a diversity of soil exists, there must almost of necessity be the kinds of produce that are cultivated. But if there is one thing to which it is better adapted than to another, it is wheat. I believe the attention of farmers here is

more directed to it, and that it is a somewhat more abundant and certain crop than it is in any of the formations before described. While corn, pork, tobacco, and hemp lead the way in these central regions of limestone, flour is the most prominent article in those of the coal and diluvium (described below).

The scenery here partakes of the same diversity as does the soil. The tendency of sandstone, in its disintegration, is to form elevated hills, sometimes moundlike in shape, and sometimes precipitous; while that of shale is to produce gentle slopes and tracts of level land. The traveller may, therefore, find almost every diversity of scenery which the whole country produces, within the limits of the coal-fields; and that too, frequently, within a very short space.

What I have now said of soils and scenery, as the result of the disintegration of particular rocks, is of necessity general; it may be thought too much so to be of any practical utility. But it cannot be expected that every man's farm can be described in such a treatise as this. Nor is it desirable that it should be. To an intelligent and enlightened farmer, it must be more desirable to become acquainted with general principles, and, by his own mental industry, to make the application of them, than to have all necessity for thought superseded by particular descriptions. My object has been, to state the results of much observation, in such a way as to furnish food for thought, and an incitement to the habit of observing.

**DILUVIUM OR DRIFT.** In the northern portion of the western country, including about half of the States of Ohio, Indiana, Illinois, and of Missouri, and the whole of Michigan, Wisconsin, and Iowa, there is distributed over the surface an immense amount of coarse and fine sand, gravel, pebbles, and boulders, consisting of almost every variety of primary and secondary rocks, lying in utter confusion, or without the least appearance of order; as if some rude hand, envious at the beautiful order of nature's mighty masonry, had broken up her works, and scattered them in disorder over the ground. That these are the ruins of rocks, broken up, and thus mingled together, by some powerful agent or agents, no liberal and intelligent mind can doubt, after a very slight examination. Here we find nearly every shade of granite, and other igneous and unstratified rocks, together with gneiss, mica slate, hornblende rocks, clay slate, primary or crystalline limestone, and the fragments of fossiliferous rocks, all piled

together in promiscuous heaps, and overspreading, to a greater or less depth, from nothing to a hundred feet or more, almost the whole of those portions of the country above specified; whereas in Kentucky, and for a considerable distance north of the Ohio river, and in the southern part of Missouri, there is nothing of the kind.

On viewing these facts, the inquisitive mind seems urged to inquire what does this mean? What can have been the causes which were sufficient to break up so many rocks round them, and transport them from their original and far distant beds into these conglomerated masses of confusion and disorder? Can these be the doings of nature, who is wont to work so systematically, and to delight in beauty and order? What could have been the matter with her, when she was performing such deeds of violence? Could she, after toiling so many ages to rear these mighty structures, whose ruins we here see, have taken delight in battering them down, and thus destroying all traces of their former regularity?

Let the causes be what they may, the fact stares the traveller full in the face, at every step, that some dreadful disaster has happened to the rocks in these regions, and particularly to those still further to the north. There is no native granite in these States; whence come, then, those huge granite boulders, that lie bestrown over the surface of these fields? I know that those who never inquire into cause and effect, will be at no loss for a solution. Their reply is, that they were made here, where we now see them, and just as we now see them. And appealing to the omnipotence of the Creator in proof of it, they will triumphantly ask you in return, if it was not as easy for the Almighty to have made these things in the form we now see them as in any other? And at last they will wind up their argument by the sage conclusion, that it would neither make our wheat nor our corn grow any better, if we knew; nor enable us to get any more money.

But this solution will not satisfy the mind that is in pursuit of intellectual wealth. He must know where they came from, and how they came into their present situation; for he cannot believe that they now occupy their native places, or that they were always here where they now lie. The evidences of his own senses compel him to believe that these masses of broken rocks are the ruins of some of nature's ancient works. And he feels that this opinion is demonstrated, when he can trace them to the very places from which they have been torn, and witness the marks of violence

through all the distance over which they have been transported. He is still more strengthened in the belief that some powerful, overwhelming force, acting in a uniform direction, must have produced these effects, when he finds that their original localities are uniformly in a certain direction from the places where they now lie. In every instance their native beds are found, when found at all, to the north; sometimes in the vicinity, sometimes many miles and sometimes several hundred miles from their present places.

So clear and overwhelming is the evidence to be seen upon these rocks themselves, in support of such a conclusion, that one with a lively imagination can almost transport himself back to the time in which these tumultuous scenes were acted, and witness this whole mass of rubbish moving along and grinding down the undisturbed strata upon which it rests.

I have said that there is no native granite or other primary rocks in these states from which this drift could have been derived. But far to the north, along the shores of Lake Superior, and extending both east and west, are mountains containing the very same kinds and variety of rocks, lying in their native beds, of which these fragments are the visible and the tangible representatives; and which the traveller, after examining these broken masses that lie bestrown over these western fields, would recognize as old acquaintances.

Some of these boulders will weigh twenty tons; and others thirty, fifty, and perhaps a hundred tons, and yet they have been transported not less than four hundred miles, and that too over the great lakes; with an immense quantity of smaller materials of the same sort, of all sizes, down to the fineness of sand. They have not all been brought to one place, nor moved to any particular distance; for nearly the whole country from these mountains, and probably still further north, is covered with them down to the middle of Ohio, Indiana, Illinois, and Missouri. (The southern limits of the drift, as nearly as has been ascertained, are represented by the small red line, extending across the map, from right to left.) This line is only an approximation to the exact boundary; it being in reality full of deep indentations, like the borders of an ocean. This drift does not often terminate suddenly, but gradually thins out; so that small portions of it are found to the south of this line, and in some places to the north it is wanting.

Whatever were the causes which tore up such quantities of rocks out of their native beds, and moved them hither, its force seems to

have been spent when it had conveyed them thus far. Their present rounded forms and smoothed surfaces, show that they were not conveyed very carefully, but that they experienced a great amount of attrition; and that it was of long continuance. And yet they appear to have been conveyed in nearly straight lines, and in a horizontal direction. The evidences of this are clearly seen, to this day, upon the surfaces of the rocks in place, in almost every part of the country, over which they now lie, whenever it can be seen. But the drift is generally so thick over these rocks, as to hide from our view all the traces of its own doings which it has engraven on them. In the limestone quarries in the vicinity of Dayton, are some of the best opportunities for observing the grinding effect of the passing drift, that have been found. There the hard limestone has been worn quite smooth, and nearly as true as it could have been done by machinery over a great extent of surface; indeed there is little reason to doubt but the rocks beneath the greater part of the country would exhibit the same, could they be seen. They exhibit upon their surfaces innumerable nearly parallel striæ, or scratches, appearing as if they had been made by the sharp angle of some hard stones, as they were made to slide over them. It is evident, that they did not roll, but slid over them, being borne down by the weight of the superincumbent mass. Nothing that we can think of seems better calculated to explain the effect, than to suppose the whole of the drift was frozen in a solid mass, and then moved southward. But there are many difficulties in the way of such a supposition.

There can be no doubt that water was largely concerned in this great movement; and as little, perhaps, that ice produced no inconsiderable part of the effect. It is probable there may be some analogy between this whole matter and the icebergs of the present day. But when we take into account the vast magnitude of the operation and of the effect produced, all analogy with any thing now going on upon the earth seems puny and unsatisfactory.

This drift is not peculiar to these western states; but is equally abundant over the whole of New York and New England; and even over most of the northern countries of Europe. It must have been produced, then, by the simultaneous action of some powerful cause, which reached over nearly one half the globe; to which there is nothing in the present order of things that furnishes any parallel, or scarcely any analogy.

*✓ former*

**SOIL OF DRIFT.** It will be seen, then, that the soil over the drift must differ materially in its origin, from that of the country which lies to the south of it. The latter is generally the product of the decay of one kind of rock; but the ~~latter~~ <sup>former</sup> consists of the spoils of almost every sort of primary and secondary rocks mingled together. This is the reason why the soil in the region of the drift, as was intimated in describing some of the preceding formations, has little or no relation to the character of the underlying rock; having been drifted upon it, instead of resulting from its direct decay. The principal differences in the soil here are such as result from the unequal and dissimilar distribution of the materials brought along by the currents or other moving powers that transported the drift.

In selecting a farm, then, in that part of the country occupied by the drift, except in a few places where it is shallow, or quite wanting, the character of the underlying rock will be no guide. Nothing but actual examination or use will make known its character; which is liable to great changes in short distances, owing to the diversity of the materials which were deposited.

The soil of this portion of the country is not at all inferior to that of the other. Being made up of a greater variety of material, it has less of a distinctive character which would cause the cultivation of particular staples to the exclusion of other things. I think its peculiar excellence, however, is in favor of wheat, which will probably take precedence of all other productions.

**LAKES.** Throughout the region of the drift there are numerous small lakes or ponds of water; but none to the south of it. This, together with other evidences, which one would see on visiting them, leads to the conclusion that they were produced, or scooped out by the same causes which transported it thither. But in what way I cannot pretend to tell. Peat bogs or marshes are likewise found abundantly in the same region; but none south of it. This also seems to have some connection with the diluvium.

**DENUDEATION.** From the great amount of drift that overspreads a large portion of the country, and the soil that covers every part of it, it is evident there has been a very great destruction of rocks in past time. When we reflect upon the great quantity of matter annually carried down the Mississippi and other rivers into the sea;

that all this is furnished by the decay of rocks ; and that this process has been going on for thousands of years, if not of ages ; it must be supposed that the present surface of the country is much lower geologically than it originally was. It is undoubtedly by this means, that all the hills, in every part of the country, have been produced ; showing that the whole country was once at least as high as their present tops. But there can be little doubt but that they have been greatly lowered. Why should the formations represented in the section at the bottom of the map, terminate so suddenly on each side of the blue limestone, leaving it, at the surface, over a portion of the country, while it dips so deep below all others at a distance ? There can be but one answer to this : they have been carried away. Number 2, on the right, once continued on, over number 1, until it met the same on the left. And I think there is good reason to believe that the same is true of all the others, even to the coal series. So that it is not improbable that the whole territory, from the Alleghany to the Rocky mountains, and from the great lakes or still further north, to the middle of Alabama, was once one continued coal-field. If this supposition be true, the amount of denudation, particularly over form. 1, must have been enormous, the present surface, where Cincinnati now stands, must have once been four or five thousand feet deep. There has evidently been an uplift here, but so gentle as not to break or dislocate the strata, extending from the west end of Lake Erie to Cincinnati, and onward in a S. S. W. direction, across Kentucky ; the whole amount of which has been carried away, so that it is now no higher than the other portions of the country.

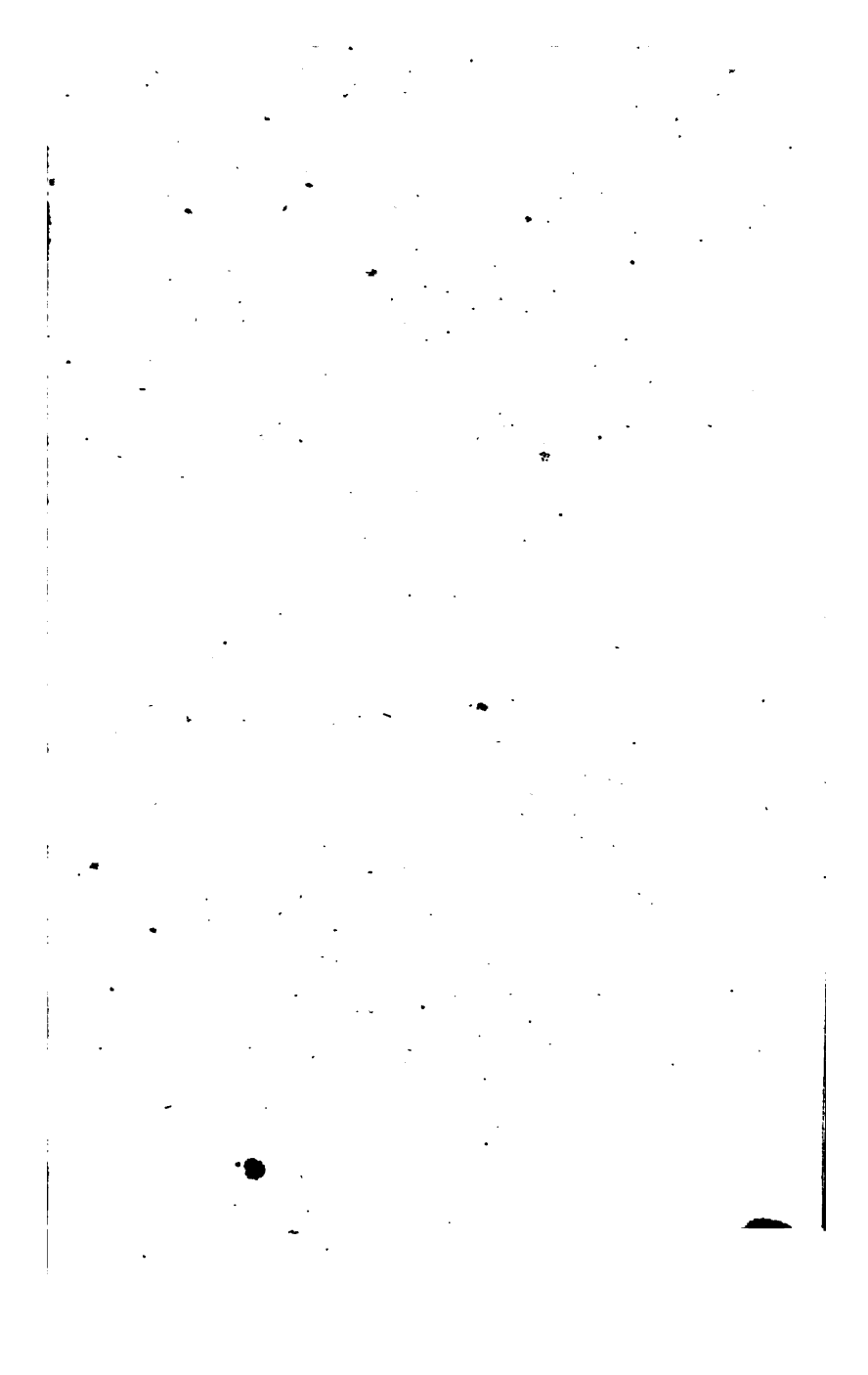
**HEALTH OF THE WEST.** Much has been said of sickness in these western states, and frequently in such a way as to convey the idea, to those who live at a distance, that it is hazardous to live in any part of them. But most of the sickness that has been experienced, is attributable to the recent clearing up of the country, which has let in the sun upon a mass of half-decayed vegetable matter ; and which greatly hastens the rapidity of its decay, and creates an unusual quantity of miasma. But this effect ceases after a few years. Many of the older settled parts of the West are now as salubrious, and the countenances of the people in their ruddy faces and rosy cheeks, demonstrate that they enjoy as high a degree of health as the people of New England. If

fevers are a little more common, consumptions are as much less so.

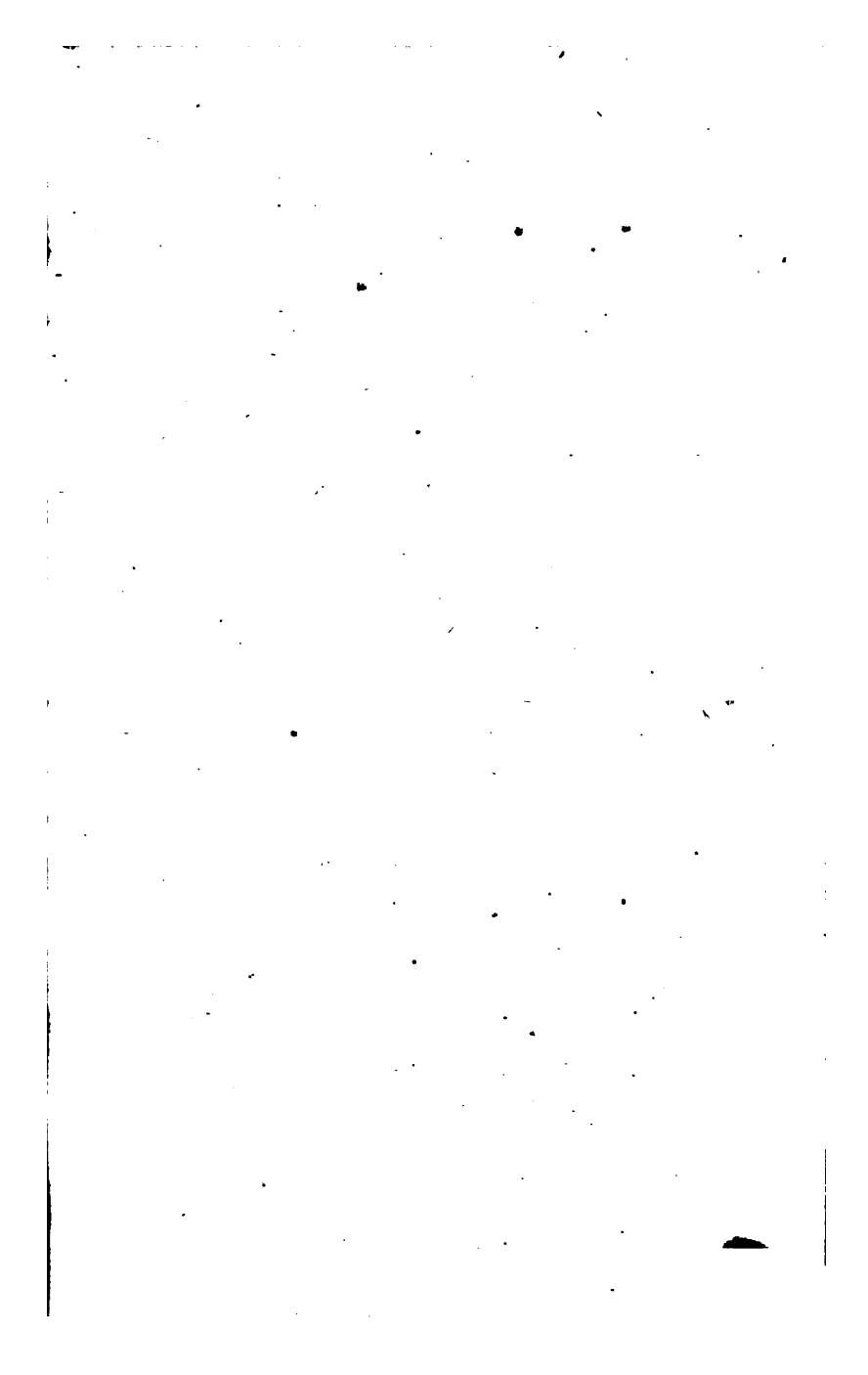
But there are great differences in the salubrity of different portions of the West, which are dependent upon geological causes. In general, the more elevated portions are more healthy than those that lie low, and the hilly parts than those that are level. Accordingly, the southern parts of Ohio and of Indiana, and that portion of Kentucky lying east of the meridian of Louisville, are more salubrious than the remaining portions. They are more elevated above the level of the sea; their general elevation being about twelve hundred feet. But the northern parts of Ohio and Indiana, with most of Michigan, Illinois, and the western portion of Kentucky are much more subject to bilious and intermittent fevers. The surface is more level and uniform; and, on an average, lies about three hundred feet lower than the preceding portions. This may be one cause of the greater accumulation of miasma, as it sinks to the lowest levels.

But, after all, the reason first assigned is the principal one, and there are few places, wherein, after the hand of culture has had time to bring about the change, there will not be enjoyed as great a measure of health, as usually falls to the lot of man in other countries. More depends upon the manner of living than upon the character of the climate. More diseases are generated by exposure, than by miasma. Alternate exposure to the noon-day sun, and the chilly dews of evening, bring on more fever and ague than all the noxious gases that arise from half-decayed vegetation.









Wm. L. G. Hardy

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